NEW PROFITS *from* IDLE DAYS

by WALDEMAR KAEMPFFERT

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Throughout the centuries runs the course of human progress. Science and invention have lent their helping hand. From the beginning, man has always built his monumental structures with the most permanent of materials. Cement, a basic medium, has developed with the race—contributing constantly to the age-old effort to add to life an ever increasing saving of time, men and money.

THE GREATEST STONE BUILDING OF ANCIENT MAN

AN ANCIENT story relates that 100,000 men toiled for twenty years to quarry, haul and place the 2,300,000 stone blocks of the Great Pyramid of Cheops, which was built about 2900 B.C. Each block weighed two and a half tons—the equivalent of an ordinary truckload of coal. This solid mass of masonry has a base 755 feet square and is 481 feet high. Twenty years of unspeakable cruelty passed during which men died like flies, before the last stone was placed at the apex. Time, men, money counted for nothing in building the Great Pyramid.

NEW PROFITS FROM IDLE DAYS

IN Gizeh, Egypt, 4800 years ago, a mighty pharaoh gave the order to build a pyramid, a veritable mountain of masonry, in which his mummified body was some day to be entombed. Khufu-onekh was the pharaoh, better known by his Greek name Cheops. Laying out a square on the desert 755 feet on each side—13 acres all told, Cheops said:

"There is the base of the pyramid."

About 2,300,000 blocks of limestone, each weighing two and a half tons, were hewn at the quarries thirty miles distant and then shipped by water and hauled from the banks of the Nile up inclined planes. Slaves were harnessed to stones. Under the lash and to the rhythmic cries of a foreman, human muscles pulled in unison. How many perished to build the pharaoh's pyramid? A hundred thousand, tradition says.

Two decades passed before the last stone was placed at the apex, 481 feet from the ground—two decades of marvelous organization and dauntless courage on Cheops' part. Also two decades of unspeakable cruelty with scores dying like flies every day.

Even in Cheops' day men wondered whether there was not a way of dispensing with a sweating army of toiling captives, of building enduring temples, pyramids, houses, palaces in years and months instead of decades. It is as old as the race—this longing to save time, men and money. And so it is not astonishing that the ancients eventually discovered cement and a way to pour it like molten metal into a mold, where it would harden and become like stone.

The Story Begins Thirty Centuries Ago

No one knows when cement was first utilized. Its history epitomizes fully thirty centuries of effort to reduce the time of building roads and titanic structures. There is reason to believe that it took many months, even a year for ancient cement to acquire service strength. Even now twenty-eight days, about a month, is required in some engineering specifications. Curing periods reduced from months to weeks, from weeks to days, and now with "Incor", from days to hours—such is the centuries' old evolution of cement.

So to tell the story of "Incor", which is the most recent chapter, we must go back 3,000 years.

Near Mt. Vesuvius lies Puzzuoli, and there a volcanic ash now called *puzzuolana* was deposited. Around Rome, too, puzzuolana is plentiful. Mixed with slaked lime and sand this puzzuolana eventually forms a hard cement. Here the Romans discovered a material out of which a one-piece wall and roof could be made. So the Romans built walls which were a mass of concrete and in which bricks were embedded, the whole often faced with marble.

Rome—A Nation of Practical Builders

Wherever there are Roman ruins, there evidences of concrete are discovered. Puzzuolana was not found everywhere in the Empire. Equivalent materials were—trass in Germany and Holland and arènes in France. For Rome's purpose there was nothing better than cement. Her engineers wanted stability, rigidity, durability, inertia, and strength. They found them all in concrete. What a material for a nation of practical builders! Inexpensive. Unskilled slaves could handle it. Formless in itself any form could be obtained by pouring it into the proper mold. No ancient people ever matched the Romans in the vastness of their building enterprises. They built in Britain, France, Spain with the aid of cement.

No jerry-building—this. What the Romans made of concrete has come down intact, when it has not fallen a prey to natural cataclysms or deliberate destruction. There is the Megara Hybalea, built in 482 B.C.; the Theatre of Segesta, erected about 300 B.C., with massive substructures of concrete; the $100,000,000 aqueduct system started by Appulius Claudius in 312 B.C. with water conduits of concrete; the Appian Way, 300 miles long, still a road because of its lava blocks laid in a crowned foundation of concrete; the famous viaduct of

Nîmes, a wonder of the world in its day, built in southern France under Augustus Caesar, with a water channel lined with concrete, now like stone; the Pantheon of Rome, the baths of Caracalla and the Temple of Jupiter at Baalbek.

In the New World it was the same. The great Mayan temples of Chitchen Itza were reared on massive platforms of rubble-concrete faced with stone. Even the terrace roofs were of concrete supported by wooden beams. Two civilizations, evolved in different parts of the world, independently discovered the flexibility and durability,—the time and labor saving properties of cement and concrete.

Note that the ancients built with blended cements—materials scattered liberally by nature over the earth. There was no attempt at uniting them by fire. Until about a century ago there were no manufactured or fired cements in our strict sense of the term. Even after they were introduced architects and engineers viewed them askance. Indeed, it was not until the process of manufacturing cement was controlled, not until the chemist was engaged to study process and product that Portland cement at last won its way.

How Portland Cement Was Discovered

John Smeaton appeared in the middle of the 18th century. When he received the contract to build the famous Eddystone Lighthouse, finished in 1759 and long regarded as a structural masterpiece, he decided to build it of cement. Certainly blended cements varied widely. Why? No one could give Smeaton a scientific answer. Cement materials were judged by their color and texture.

Chemistry was still weak, so that accurate analyses were not possible. Yet Smeaton experimented with cement intelligently. With him begins the story of research culminating in "Incor".

Smeaton's great discovery was this:

What was called "impure" limestone, because it contained clay, made the best cement. Smeaton then realized the importance of lime and clay which had been mixed by nature in the proper ratio. Moreover, he found that the clayey limestone *had to be burned*. "I do not doubt that I shall be able to make a mortar equal to Portland stone," said Smeaton. What he produced is now generally known as natural or Rosendale cement.

It was not Smeaton who founded the Portland cement industry. Cement makers who burned lime were careful to avoid high temperatures. In fact anything like clinker was rejected as worthless. So it happened that the man who gave modern cement-making its real start was Joseph Aspdin of Leeds, a bricklayer with a genius for hocus pocus. After thirteen years of experimenting he patented a cement in 1824. "Portland cement" he called it because it was so like the fine building stone that came from the Isle of Portland. A demand for it sprang up almost immediately. Here was a material with which time, men and money could be saved.

A Bricklayer Turned Inventor

Those were the days of brick-walled secrecy. No one was permitted to enter Aspdin's mill, except employees. And the employees were completely mystified. Clad in the flowing black gown of the story-book mystic and wearing a medieval pointed hat, Aspdin made a magical rite of his process. He burned his materials until they became clinker. After a kiln had been charged he approached, solemnly bearing a tray of copper sulphate, powdered limestone and other compounds. A handful of this, a pinch of that, mutterings, incantations—such was Aspdin's way of throwing the curious off the scent.

One at least refused to be mystified. He was Isaac C. Johnson, manager of a rival cement factory, bent on finding out why "Portland cement" was so good. That Aspdin burned the usual clayey limestone or limestone and clay in a kiln with coke as a fuel he knew. But that alone did not explain the excellence of the final product. So the practical Johnson, living in a time when chemistry was more highly developed than it was in Smeaton's day, had a sample of this cement analyzed by a first-class chemist. "Forty-five per cent phosphate of lime" read the report quite erroneously, thereby misleading the inquisitive Johnson. He bought cartloads of bones, burned them in the open and mixed the resulting phosphate with clay and other compounds indicated in the analysis.

Bones proving to be a failure, Johnson undertook some real research on his own account. In the end he discovered independently what he wanted

ROME'S GREATEST CONCRETE DOME

THE Pantheon, rebuilt in its present form about 125 A.D., stands as a monument to the strength and durability of concrete. Architects and engineers marvel at its hemispherical dome, 142 feet in diameter, built of rubble-concrete with blended cement as a base. Puzzuolana, as the cement is now known, hardened so slowly that the forms by which the dome was temporarily supported must have remained in place for many months. Despite the passage of centuries, the concrete in the dome is still in excellent condition.

to know. It was not enough merely to burn clay and limestone. *The temperature had to be high*—high enough to bring the materials in the kiln almost to the fusing point. Aspdin's success proved to be due in part to a crude but better chemical control of his raw material and to a fine grinding, which made it possible to obtain uniform mixtures and to produce a clinker of the right type. That high heat was necessary to obtain the best cement was not an original discovery with either Aspdin or Johnson. Vicat, Treussart and St. Leger, all chemists on the Continent, knew it, and probably others too. Portland cement is therefore an evolution and not the result of a single flash of genius.

Portland Cement in Europe

Twenty-nine centuries of cement have brought us thus far in the quest of the best way to save time, money, men:

1. Puzzuolana, or blended cements were mixtures of lime and volcanic ash. Before they could be placed in service, months, even a year, must elapse. Still the Romans and their successors reduced the time of building from decades to years.

2. Natural cements, as their name implies, were made from unprepared clayey limestones. They were fired at low temperatures to drive off gas, but were not fire-united. Months elapsed before these natural cements acquired service strength.

3. Portland cement, Aspdin's discovery, can be made a more uniform product than natural cement. Its raw materials (lime and clay) are proportioned and well ground to obtain uniform blends and are fired almost to the melting point to produce a new chemical union. The resultant clinker, when ground, is Portland cement. It hardens more rapidly than natural cement, yet at first it could not be placed in service for weeks. Puzzuolana, natural and Portland cements are totally different chemical products.

Cement mills sprang up everywhere in Europe after Aspdin achieved his great success. In the United States the progress of Portland cement was slow, chiefly because of the immense deposits of cement rock from which excellent natural cement could be made. As late as 1898, about seventy firms operating 100 plants were producing natural cement in fourteen states. About half the production was Rosendale cement, so named because it first came from the Rosendale district in Ulster County, New York. These natural cements, like those of the ancients, were ill-adapted for self-supporting structures. Hence their principal use was in foundations, where mass and dead weight counted.

Portland Cement in the United States

After the Civil War and the opening of the Reconstruction Period, Portland cement began to make its way in the United States. Such was its European reputation for strength and for rapid-hardening, compared with natural cement, that American engineers began to specify it, especially for foundations and massive structures. But always English, French, Belgian or German Portland cement was insisted upon. In fact no one in America knew how to make a Portland cement that was as good as natural, Rosendale cement. In Europe reinforced concrete was coming to the front. It broadened the field for Portland cement and revealed possibilities in self-supporting structures that could not be realized with natural cement.

It was European competition that placed the American Portland cement industry where it stands today. David O. Saylor, owner of a small natural cement mill in the Lehigh Valley, began to experiment. Like other natural cement makers he fired his rock at low temperature in the approved fashion and threw away any clinker that was produced accidentally. What if this rock were treated in the European way—fired at high temperatures to produce a clinker? He burned rocks in his kitchen and deliberately brought them almost to the clinker stage. In 1871 he patented his process. "The stone which I use for the purpose contains the same ingredients as the composition used for making Portland cement, and the products cannot be distinguished from each other except by treatment," he said.

But Saylor was not so successful as he thought. His patent of 1871 says nothing about grinding the raw rock to powder—one of the essentials in the Portland cement process. His rock varied in quality. Instead of despairing, he had analyses made. He saw that what he needed was chemical control of his process. And so he hired a chemist—young John W. Eckert of Lehigh University. Cement re-

LAVA BLOCKS LAID IN CONCRETE NOW 2,200 YEARS OLD

ROME held her empire together by the finest system of purely military highways the world has ever seen. Concrete was used freely in their construction. The Appian Way, for instance, which ran for 200 miles from Rome to Capua and later to Beneventum and Brundisium, had a crowned foundation of concrete in which lava blocks were laid. The road was built in the third century B.C. Many a triumphal procession entered Rome on this world-famous highway. Several sections of the original road are still in use.

search in the United States began then and there. The laboratory had taken charge of the cement mill. In the sixty years from 1872 to 1932, more progress was made than in the thirty centuries that led to Aspdin.

Nowadays cement-making is chemically controlled at every stage. Raw materials are crushed and mixed in carload lots. Yet no druggist compounds a prescription more carefully than a cement chemist measures and weighs the tons that pass through a modern mill. Any natural substance that contains sufficient lime is quarried. Marl, limestone, oyster shells, "cement rock," chalk—these are the principal sources of lime.

Changing Nature's Materials into Cement

The chemist is no longer interested in such vague designations as limestone and clay. It is what the limestone and clay contain that is important. So he talks of calcium, which is the principal ingredient of all limes; silica and alumina, which are the basis of clay and also occur in rock. He sees to it that his raw materials are carefully proportioned and that the end product is of the desired chemical composition. The range of composition for cements generally is 60 to 65 per cent calcium, 20 to 24 per cent silica, 5 to 8 per cent alumina.

Such cold figures convey nothing of the change that takes place in what was once mere rock. Matter must be torn apart into the atoms and molecules of which it is made, and then these atoms and molecules must be rearranged to build up something of which nature never dreamed. It takes tremendous energy thus to reform rock, the stuff of which this planet is made. There must be a smashing of the rock into little particles by crushers and grinders and then the little particles must be still further smashed by terrific heat—chemically smashed, shuffled and recombined so that their very nature is changed. Rome's puzzuolana came out of volcanoes. Once it was rock deep within the earth.

Portland cement is as much a product of heat as that ancient Roman cement. And the rotary kiln of a modern cement plant is a man-made volcano through which a flame roars that must be controlled to prevent ground rock from melting and becoming lava—a flame that has a temperature of 2500 to 3000 degrees Fahrenheit. What was once an inert mixture of mere lime and clay is changed to a collection of molecules which becomes chemically active as soon as they meet water. The whole problem of making Portland cement better and better, of reducing the hardening period from weeks to days is a matter of this activity. The more active the molecules the sooner service strength is acquired, and, as "Incor" has proved, the stronger is the resultant concrete.

Portland Cement—Forerunner of "Incor"

"Incor" is like the modern electric lamp, the transatlantic telephone, the sound picture and scores of other modern triumphs in this: It could not have been deliberately developed by research without a practical basis. There had to be a steam-engine before there could be a science of thermodynamics which gave us better boilers and the modern turbine. There had to be Edison's carbon-filament lamp before a research staff could develop the tungsten lamp. There had to be mauve, first of hundreds of coal-tar dyes, before there could be synthetic drugs, flavors, photographic developers. There had to be gun-cotton before there could be a conversion of cellulose into scientifically created substitutes for ivory, leather, silk, paints and varnishes. The practical man must always precede the scientist. So with "Incor". There had to be Portland cement before there could be research that resulted in "Incor".

From 28 Days to 24 Hours

That research concerned itself with fundamentals. What is Portland cement? Chemists had been trying to answer the question for a hundred years; for out of the original lime, clay and silica came, through a process of fire-unification, a product of bewildering complexity. What happens when water is added to Portland cement? Why does Portland cement become as hard as granite? What becomes of the water that is added? What is the process of hardening? Can the hardening period be reduced so that time, men and money can be saved, and a road or a structure placed in service in days, instead of weeks? Questions like these have concerned chemists and physicists ever since Aspdin discovered

A CONCRETE STRUCTURE THE SEA COULD NOT DESTROY

THE Eddystone Lighthouse, finished by Smeaton in 1759, is famous not only as a beacon but also for its cement foundation. Smeaton conducted research to discover the best hydraulic cement for his purpose. He found that a clayey limestone when burned, gave him one as good as Portland stone. His lighthouse stood for 125 years and was replaced by one which was so high that the waves could not dash over the lantern. Smeaton's lighthouse was reassembled in a public park at Portsmouth, England, as an historical monument.

Portland cement and the way to make it. Because some were answered it became possible not only to make better cements, but cements that would acquire service strength in ever-lessening periods. A few years ago the time specified by engineering societies for Portland cement to acquire service strength was placed at 28 days. Then came step-by-step reductions to 21 days, 14 days, 7 days and finally "Incor".

And Now—"Incor"

"Incor" is the next step after Portland cement. Iron is to steel what Portland cement is to "Incor". And the difference between iron and steel is no greater than the difference between ordinary Portland cement and "Incor". Portland cement, once an end product, is now an intermediate product in the making of "Incor".

We have seen how ordinary Portland cement is made—how lime and clay in a finely ground form are all but fused at high temperature to produce a clinker, and how this clinker is in turn finely ground to form the fine gray powder that we call Portland cement. At this point the "Incor" process begins. The powdered clinker is turned back into the kiln *with extra lime*, if necessary, *and burned again*. And again the clinker obtained is ground into powder, this time of exceeding fineness. This is "Incor". It is a revolutionary type of Portland cement with revolutionary capabilities. It has the marvelous property of becoming serviceable in twenty-four hours, instead of in seven to ten days.

Saving Time, Men and Money

Here we have a fresh advance in cement engineering, a saving of idle time valued at hundreds of millions yearly, a new way of planning the construction of roads, bridges, buildings and other structures of concrete. Look back now and visualize the progress made through centuries until "Incor" was reached.

We begin with blended cements. How long did it take those of the ancients to harden and acquire service strength? We can only guess. Modern tests made on similar mixtures of puzzuolana and lime indicate that many months, possibly years elapsed before forms and centers could be removed.

Those forerunners of modern cements, the first fire-united naturals of Smeaton's day differed from the ancient product only in degree. Service strength came only after months of waiting.

The evolution of Portland cement strength has been striking. We do not know how much time elapsed before Aspdin's cement could be put into service. We do know that in the latter part of the 19th century service strength was a matter of months; in the early part of the 20th, several weeks. Specifications of 1915 required 28-day curing before concrete could be used. Since 1920, dead time has been cut to two weeks, then to 10 days.

And now "Incor" surpasses in one day the seven-day specification of the American Society for Testing Materials for ordinary Portland cement. After three days "Incor" has a strength in excess of 375 pounds to the square inch, whereas the Society requires 350 pounds only after twenty-eight days.

In thirty centuries we see the service strength of cement reduced from one year to one day.

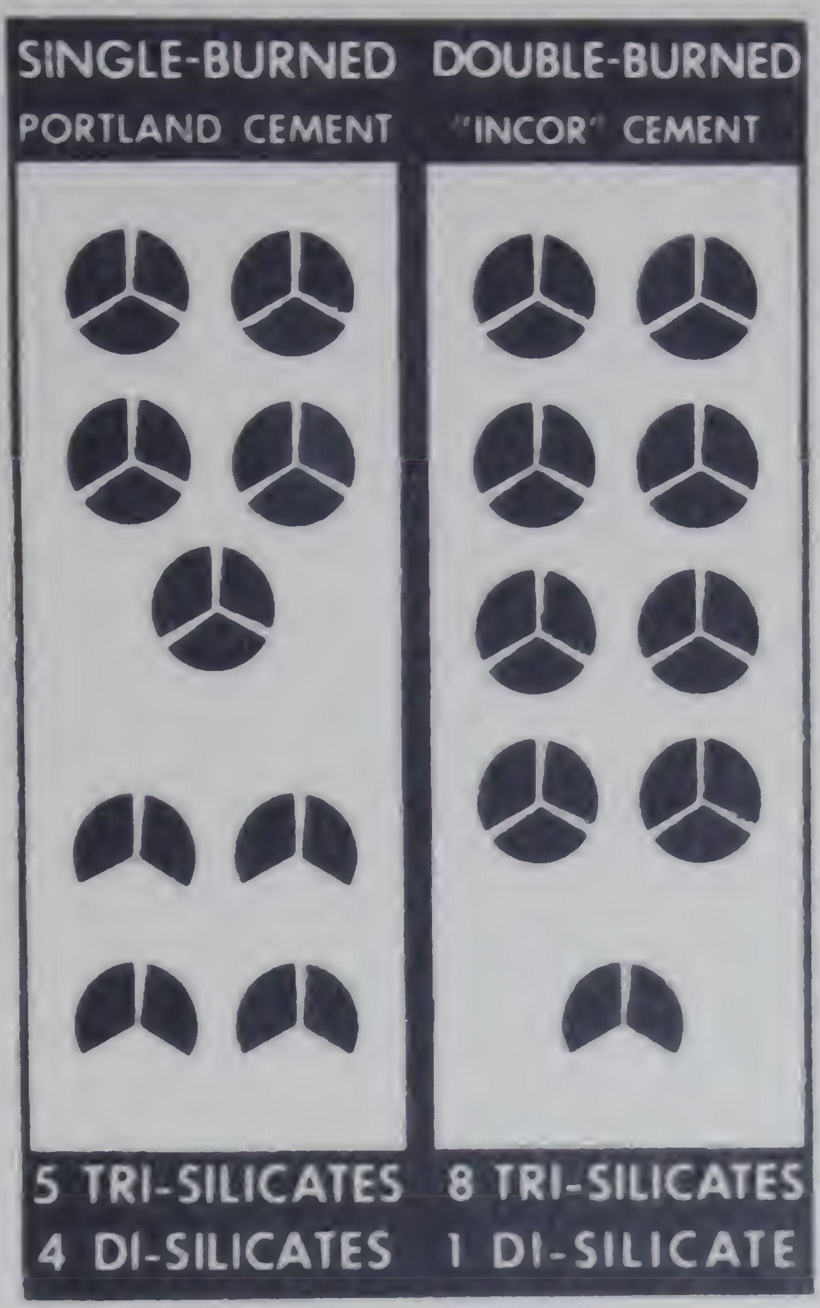
A New Standard in Cement

Research chemists distrust success after long periods of failure. So the "Incor" chemists became critics of themselves and their new product. The first "Incor" produced on a commercial scale was subject to gruelling tests, running into the thousands. Compression machines crushed specimens made from "Incor"; other machines pulled them apart. The strengths at the various ages were compared with those obtained when precisely similar specimens made with ordinary Portland cement were tested. Cores were taken from "Incor" roads at different ages and tested with similar cores of roads made with ordinary Portland cement. Five years of this. A new standard of cement performance had been established.

"Incor" was used on a state highway for the first time in May, 1927. A gap was closed on U. S. Route 20 at the Père Marquette underpass, near Springville, Indiana. Cylinders were molded as the concrete of "Incor" was spread and tested in compression. One-day-old cylinders were found to have a strength of 2198 pounds per square inch!

Forty-eight hours passed. More cylinders were crushed. This time 4109 pounds.

When four weeks old—4939 pounds!



HOW "INCOR" DIFFERS

THE important constituents of Portland cement are tri-calcium silicate and di-calcium silicate. It has long been known that the *pure tri-calcium silicate alone has all the properties of a true Portland cement.* Not only this. It hardens much more rapidly. On the other hand *pure di-calcium silicate hardens only after weeks.* Tri-calcium silicate is *stronger* than di-calcium silicate.

Single-burned cements consist, among other things, of *both silicates.* Usually there are about as many tri-calcium silicates as di-calcium silicates. Cement would be much better, would cure more rapidly, if there were fewer di-calcium silicates.

A *tri*-calcium silicate clearly contains more lime than a di-calcium silicate. To convert the *di*-calcium into *tri*-calcium silicate obviously means more lime. Extra lime and a single-burn results simply in a Portland cement with an excess of uncombined lime, but not in "Incor". If the lime-content is too high the cement may actually be inferior in quality.

Hence we have this dilemma:—Double-burning alone does not yield "Incor". Excess lime by itself will not produce a high-early-strength cement.

How simple the solution seems now. First make ordinary Portland cement. Analyze it for lime. If there is a deficiency in lime, add enough to convert the *di*-calcium into the *tri*-calcium silicate. High heat effects the change. So ordinary Portland cement, with a slight excess of lime, is burned again. Out of the kiln comes a new kind of clinker. Grind it to the requisite fineness. "Incor".

As shown in the diagram, in ordinary, single-burned Portland cement the proportion of tri-calcium to di-calcium silicates is, say, 5 to 4; in double-burned "Incor", 8 to 1. "Incor" is, therefore, nearly all tri-silicate.

SEVEN WEEKS SAVED IN REPAVING DRIVEWAYS

THE Central Cold Storage Company of Chicago repaved the eight driveways leading to its shipping bay. At least six must be in constant use. All were carried over a sidewalk and vault by a structure that must be wrecked and rebuilt. An ordinary Portland cement schedule would have taken each driveway out of service for sixteen days, requiring nine weeks to complete the job. With "Incor", each was placed in service after 48 hours. The whole job took only two weeks. Full delivery facilities were restored nearly two months sooner.

FROM FORTY-FIVE DAYS TO THREE

SPECIFICATIONS of New York's Department of Docks for the 46th Street Pier, East River, required 45 days curing and aging for piles made with ordinary Portland cement. Piles were 14 inches square and 40 to 74 feet long. Tests satisfied the Department that "Incor" piles, three days old had the required strength to withstand the terrific punishment of driving. Thus 42 days' time was saved the contractor on the job. During the last foot of penetration one "Incor" pile took 1900 blows from a three-ton hammer without apparent damage.

In August, 1931, four years and three months later, cores were drilled from the pavement and tested in the presence of public officials. An average strength of 9604 pounds per square inch. Never was there a cement like this.

Since this first test in actual service was made, "Incor" has entered into the building of hundreds of miles of concrete road in many states. Under varied conditions, it has produced concrete of traffic strength in 24 hours. Experience has shown that the compressive strength of "Incor" after 24 hours is 2.7 times that of ordinary cement; after 7 days 1.5 times, and after one year 1.1 times. We have, then, this comparison of concrete strengths at various ages:

Concrete Compressive Strength
in Pounds Per Square Inch

Age	*Ordinary Portland Cement*	*"Incor"*
1 day	780	2,150
3 days	2,060	3,370
7 days	2,750	4,160
28 days	3,810	4,680
3 months	4,410	4,906
1 year	5,000	5,400

The High Cost of Detours

Translate the 24-hour service strength of "Incor" into terms of the 27,000,000 automotive vehicles that roll over the 24,000 miles of hard pavement laid each year in the United States. Dislocation of congested fast traffic entails economic loss. Think of 60,000 miles of detours in the United States, each about 2¼ times longer than the main route. Think of an average of 400 extra miles that every car must travel at a total operating cost of $400,000,000. Then think of the possibility of saving at least $240,000,000 of this loss because "Incor" concrete can be placed in service, not in the usual seven days, but in one.

In the past ten years automobile traffic has more than trebled. Due to increased efficiency in road-building, twice the length of curing concrete is now barred to traffic at a given time.

Thus the difficulty of detour elimination is six times as serious as it was in 1921. Because "Incor" Cement concrete can carry traffic 24 hours after it is placed, in the large majority of cases it is no longer necessary to close a highway during construction. Traffic now continues to use the main highway. Detours are eliminated.

How "Incor" Eliminates Detours

A detour must be prepared or conditioned, drained, shaped and graded. Frequently stone and gravel must be spread and packed to carry heavy traffic during the period of main-line construction; the roadbed widened; a guardrail or other safety structures erected.

H. G. Shirley, State Highway Commissioner of Virginia, says:

"On 936 construction jobs scattered through the various states taken at random, we find that of this number 588 had detours and 348 were carrying traffic either adjacent to or over the construction work; approximately two-thirds of the traffic being detoured and one-third carried over the construction."

In 1930, detours in Pennsylvania were 819 miles longer than the corresponding main highways. Over these 819 extra miles, an average of 825 vehicles ran daily for a period of 120 days at an additional cost of $11,350,000. Listen to W. A. Van Duzer, then Assistant Chief Engineer of Pennsylvania Department of Highways, as he speaks of these detours:

"We find the public not only financed road improvements but also spent about $11,350,000 in additional operation costs with nothing in return. . . . Had it been possible to use this huge sum in building additional roads, *over 200 miles could have been constructed.*"

And he adds:

"The traffic detour is more important to the public than the problem of highway construction."

What is the remedy? Paving a half-width section of road with "Incor" and opening it after twenty-four hours. One-way traffic lanes are so reduced in length that very little traffic delay results. In most cases detours are avoided entirely.

See, now, how this principle works in practice.

Between Clay City and Noble, Illinois, on Route

$32,000 SAVED AT LOWVILLE, N. Y.

TWO thousand eight hundred cars and trucks passed daily over the five-mile section of Route 12 near Lowville, N. Y. Had ordinary Portland cement been used these vehicles would have been diverted to a detour but 1.5 miles longer than the main road, yet at a total cost of $40,000. Detouring was avoided and $32,000 saved car owners by using 24-hour "Incor" to repave the main road in half-width sections. Except in the immediate vicinity of the mixer two-way traffic was maintained at all times. Concrete poured one day was open to traffic the next.

12, was an unpaved gap two miles long. To close the gap while ordinary concrete was laid meant a detour 13 miles longer. At Van Duzer's figure of 14 cents a mile the detour would have imposed an added cost of $3,458 a day for 1900 cars—a total of $76,000 for the duration of the job. But there was no detour. Except for a short, half-width stretch where 24-hour "Incor" was being mixed and laid, the entire road was available for two-way traffic. At an extra cost of only $1,500 an economic loss of $76,000 to car owners was avoided.

"Incor" and the City Business Man

Within the city, detours affect not merely the owner and occupants of an automobile but the business of merchants and retailers. It has been estimated that the loss sustained by business men through the diversion of traffic amounts to $300,000,000 yearly. Sixty per cent of business opportunity depends on location. Close a street and that opportunity is largely destroyed. Lost profits are never regained.

"Incor" saves from four to nine days in opening closed pavement lanes to traffic. The work of paving is concentrated in one block. Abutting property is never obstructed by curing concrete more than 24 hours. The cost is so slight that it is negligible in comparison with the business losses avoided.

Consider these examples:

The time: December, 1929. The place: New Orleans. Canal Street, the principal thoroughfare, and the stage for the annual Mardi Gras, needed repaving for eighteen blocks—sidewalks, pavements, four-track street railway. If ordinary Portland cement had been used, street traffic would have been demoralized for months; street cars rerouted; business penalized. "Incor" was specified. The car track was completed in one quarter the normal time with no loss of income to the traction company. Each block was completed eleven days ahead of normal schedule. At an extra cost of only $28,500 Canal Street merchants were saved $200,000 in net profits that would otherwise have been lost, which at a 5 per cent profit represents a gross business volume of $4,000,000.

Scores of such examples could be cited. All give evidence that old-fashioned paving methods and ten-day curing periods for the concrete highways and bases are anachronisms.

Piling—Railroad Tunnel

Wherever concrete is used—the same story. Here are more instances of time, labor and money saved, taken at random from hundreds like them:

The East 46th Street Pier, New York City, must be rebuilt by the Department of Docks. Concrete piles 14 inches square and 40 to 74 feet long are specified. In addition a total of 45 days must be allowed for curing and ageing the piles. Tests convince the Department that "Incor" piles can be driven three days after they are poured. One pile takes 1900 blows from a three-ton hammer for the last foot of penetration. Pile butts, after driving give slight evidence of the punishment they have received. By cutting idle time from 45 to 3 days construction costs are reduced. And because of the high early-strength of "Incor"—risk of damaged piles is minimized.

The Moffat Tunnel, six miles long, is being driven through the Rocky Mountains. It must be lined. In the middle a shifting mass of soft rock and earth is encountered. In places the pressure reaches fabulous intensities. Heavy timber bracing is crushed to half its thickness. To prevent cave-ins, steel beams are used to support a mountain until reinforced concrete can take the load. Because of the moving mass of earth, concrete must harden rapidly. "Incor" lining acquires service strength in from 12 to 18 hours. All bracing is removed after six days. "Incor" gives no sign of the tremendous load that it is carrying. Nearly five years pass. To the weight of a mountain, water seepage and train vibration have been added. The "Incor" lining is in perfect condition.

Seven Weeks Are Saved

Eight driveways extend from the sidewalk to the loading platforms of the Central Cold Storage Company of Chicago. Not more than two out of eight driveways can be out of use at one time. Moreover the whole shipping bay and sidewalk are carried over a vault and basement. To create a new structure of columns, girders and floor slabs means that each driveway is useless for sixteen days and

MERCHANTS SAVE $200,000 NET PROFITS

WHEN eighteen blocks of sidewalks, pavements and a four-track street railway had to be repaved, the merchants along Canal Street, New Orleans, faced serious losses because traffic would be barricaded from their doors. Instead of ordinary Portland cement, 24-hour "Incor" was used. Each block was completed 11 days ahead of schedule. It was unnecessary to re-route street-car lines. Traffic interference was slight. Retail stores saved $200,000 in net profits which would have been lost had ordinary Portland cement been used.

HOW $1,000 A DAY WAS SAVED

BY USING "Incor" in the construction of Louisiana's State Capitol the contractor reduced the curing period of 1400 piles by 70 per cent . . . dispensed with half the number of forms required for ordinary Portland cement . . . did his casting in a yard 30 per cent the usual size . . . began driving 21 days earlier than would have been possible with ordinary Portland cement. During this period, the State was forced to pay $1,000 a day in rentals. The twenty days gained saved $20,000 in rentals to the State.

TRAINS RAN OVER THE BRIDGE AS USUAL

THE Myrtle Avenue Railroad Bridge at Jacksonville, Fla., forms a bottle neck in the yard through which all East Florida traffic must pass. When it was rebuilt, "Incor" made it possible to restore each pair of tracks to service in forty-eight hours. Train schedules were maintained. The period of possible damage from train vibration was minimized. A total of 100 days in yard interference was saved. Extra switching and operating costs were avoided. And overhead costs were reduced by earlier completion of the work.

that confusion reigns for nearly two months. By using "Incor" the whole work is done in two weeks. Seven weeks of idle time are saved. Today the additional cost of the "Incor" required would be only $200.

In drilling an oil well for the Shell Petroleum Corporation, Lake Charles, Louisiana, a cavity is encountered at a depth of 2870 feet. Work cannot proceed. "Incor" closes the cavity. Drilling is resumed in 60 hours.

The Pennsylvania bridge at Greenup, Illinois, is the last link in a new main line section which cannot carry traffic until the floor concrete has service strength. The first train moves over the new route three weeks sooner because 24-hour "Incor" is used.

A new shipping platform for the Indianapolis Street Railway Company must be built without losing a working day. "Incor" solves the problem.

This Dairy Was Never Shut Down

The badly worn and patched floor of the Walnut Grove Dairy, Alton, Illinois, must be renewed. A single day's shut-down is impossible. "Incor" has been used before for machinery bases without interfering with dairy processes. It is specified again. By using traprock chips, high-grade sand and warm water, the work is done during the daily five-hour idle period. Concrete poured at midnight is hard at 5 A.M. when plant operations are resumed. After three years of hard service during which filled cans are dragged across it, and milk is spilled upon it, the "Incor" floor shows no sign of wear.

Larchmont Avenue, Larchmont, New York, must be repaved. It runs past a firehouse. To avoid delay, "Incor" is used in front of the station, so that the fire apparatus can be kept inside and still reach the Boston Post Road nearby if an alarm sounds. The new pavement is laid in half-width sections; concrete poured one day is open to traffic the next, ready for the engine if needed. Ordinary Portland cement could not have hardened sufficiently in even a week to support a heavy fire truck.

Nine concrete arch-bridges must be built in Allegheny County, Pennsylvania, to carry the five-million dollar Ohio River Boulevard over valleys and ravines congested with traffic. The bridges are completed in winter instead of the following summer, 220 days ahead of schedule by adopting "Incor". Forms are transferred with little modification from one arch structure to the next. In the Engineering-News Record of September 25, 1930, the engineers who performed this feat wrote thus of a certain high-early-strength cement (meaning "Incor"): "The small additional cost was considered of little account in view of the advantages gained in the earlier completion of the bridges and the elimination of delay."

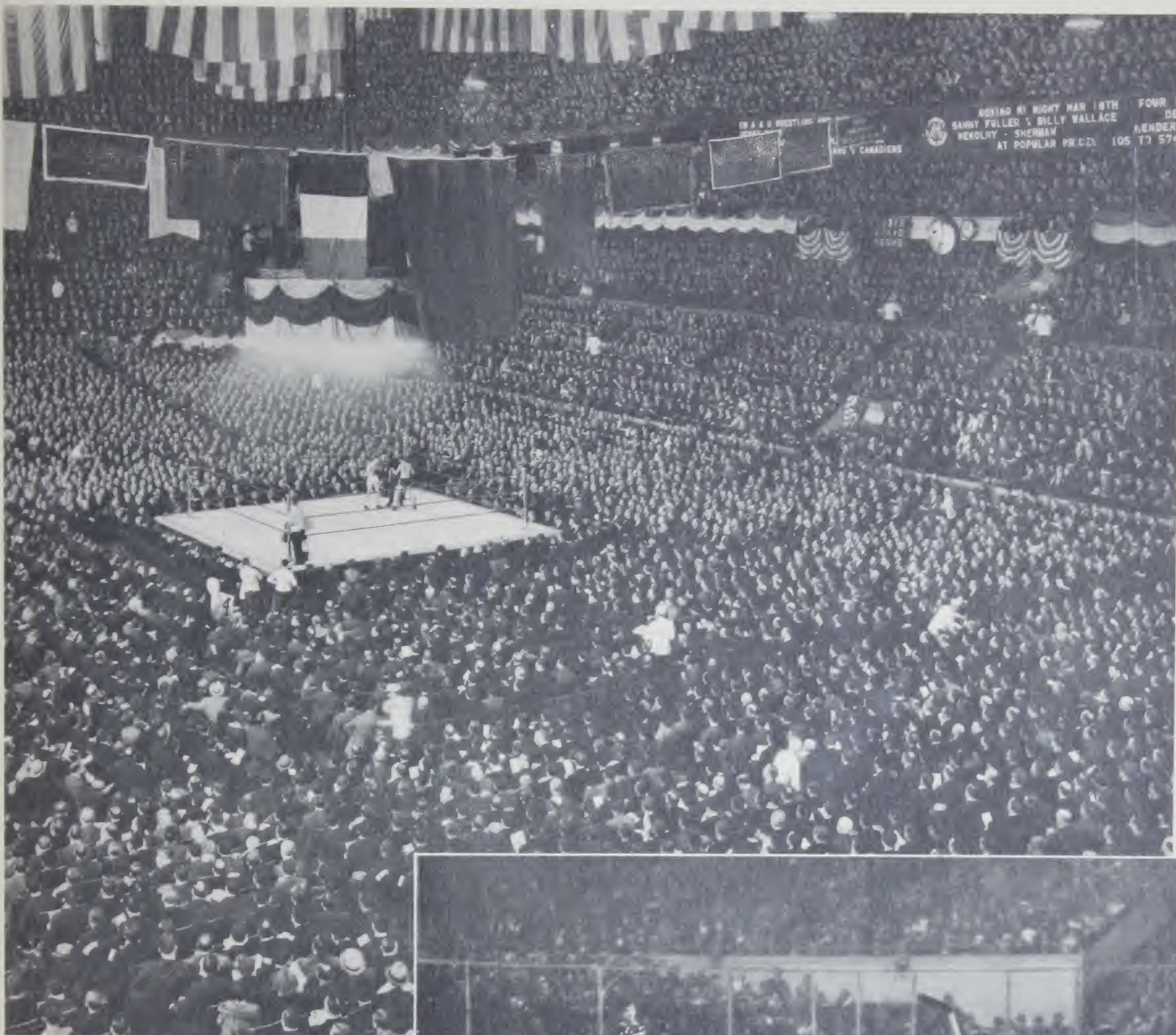
Another World's Record Broken

Madison Square Garden in New York City must be ever ready for a boxing-match or a horseshow, a circus or a six-day bicycle race. Changes must be made rapidly if gate receipts are to be insured. In the floor 12 miles of brine pipes are embedded to freeze the ice rink for hockey matches. Constant use and quick changes had damaged the Garden's floor at the height of the hockey season. Smooth, uniform ice can be frozen only over a perfect surface . . . "Incor" saves the day. Beginning at midnight damaged sections are dug out. By eight the following morning "Incor" is in place. In the late afternoon brine is turned on. That evening the hockey rink is frozen,—an unheard of test for any cement. A well-known authority states that five Madison Square cycles of freezing and thawing represent a year of exposure to a rigorous northern climate. Thus far, "Incor" in five months has withstood 49 cycles—the equivalent of 10 years of seasonal expansion and contraction—and is still in perfect condition.

Saving Three Months and $70,000

After the remarkable savings on the nine bridges of the Ohio Boulevard, the contractor solves the problem of the George Westinghouse Bridge also with "Incor". Here are the facts:

In East Pittsburgh lies Turtle Creek Valley. Within the valley is a maze of narrow streets with double-tracked trolley lines, a twisting automobile highway which has seven intersections in 1500 feet and which is frequently blocked while trolley cars receive and discharge passengers from the Westinghouse plant. Through this congested valley the Lincoln Highway now passes. The widening of the existing highway and the development of



ANOTHER WORLD'S RECORD BROKEN IN MADISON SQUARE GARDEN

QUICK changes are the rule in Madison Square Garden, New York—prize fight to hockey to circus. Needed floor repairs must be made between sporting events. During the hockey season, ice was melted at midnight; an "Incor" concrete floor-patch was in place by 8:00 A. M. Late that afternoon ice was frozen for the night's hockey. Forty-nine cycles of freeze and thaw, yet the "Incor" concrete is in perfect condition.

parallel routes entails the condemnation of too much valuable real estate at heavy cost. In order to carry the Lincoln Highway over the valley, a reinforced concrete viaduct, the George Westinghouse Bridge, is being constructed. It is 1520 feet long. The central span, 460 feet long and 156 feet high, has the distinction of being the longest concrete arch in America.

Centering Reused in 3 Days

The contractor's fixed charges are $1,000 a day for falsework and payroll. In addition it is winter, when concrete is apt to freeze, and additional expense must be incurred for heating. Faced with freezing weather and a schedule that allows no idle time the engineer, George Hockensmith, Vice-President of the Booth and Flinn Company, does some figuring. Ten to fourteen days for ordinary Portland cement concrete to harden! Too much. The schedule cannot be carried out. Besides a sudden rise or fall in temperature would cause the centering to expand or contract with disastrous results to the concrete arches. "Incor" is used for the keyways of the ten arch ribs. Concrete is maintained at 70 degrees during cold weather. "In all cases the centers were actually released three days after placing the last concrete in the rib," says Mr. Hockensmith. "In this way approximately 95 days were saved on the job as a whole. The organization and equipment were kept at work without reduced efficiency." Work begun on May 15, 1930, is finished December 28, 1931. "Incor" reduces idle time by over three months and saves $70,000 for the contractors.

When Winter Comes

The case of the George Westinghouse Bridge is striking because of the double service performed by "Incor". Note that the forms remain in place only during the brief period required for "Incor" to acquire service strength and that they are rapidly transferred from section to section. Note, too, that the work is not interrupted because of freezing weather—again because of the ability of "Incor" to harden rapidly. The story is repeated in any type of construction where "Incor" is used. Let us tell it first in terms of winter.

As you know, water is an essential part of concrete. It makes possible the hardening, strength-gaining action. This process, called hydration, is checked in freezing weather because the water turns to ice. Moreover, the concrete is usually damaged.

Building construction twelve months in the year is possible only with the aid of artificial heat in the winter months. Heat means extra cost, not only when concrete is mixed but for the whole seven-day period required for the hardening of ordinary Portland cement. Not so with "Incor"! You heat it—keep it warm for only 48 hours. After that the temperature may drop to zero. Hydration is well advanced, and water as a liquid has ceased to exist in the concrete. The time of costly heating reduced from 168 to 48 hours. The risk of damage by frost is minimized. The work goes forward at virtually summer speed. The saving in coke alone frequently pays for the slightly added cost of "Incor". With modern planning and "Incor" there is no reason for postponing building construction in winter.

Fewer Forms and Faster Building

Profits in reinforced concrete building construction can be made only by efficient and rapid methods. Delays mean penalties; time saved—bonuses. Much depends on the rapidity with which forms can be removed and set up for refilling. And this in turn depends on the curing period of the concrete. Hence the difficulty of planning operations to conform with a schedule. With one set of forms and ordinary Portland cement the non-productive curing period is seven to fourteen days. Carpenters and bricklayers are laid off while concrete hardens to service strength. With several sets of forms—faster construction, higher form costs and a multiplicity of operations result.

"Incor" shortens the building contractor's schedule and results in a new and more efficient method of rapid construction. Instead of a week or two for hardening, only a day. No extra cost for forms. The equipment required is reduced to a profitable minimum. The usual delay of two weeks, with its interfering shores—required while ordinary Portland cement gains service strength—is converted into productive time. "Incor" permits the removal of forms without reshoring, so that

MAKING UP FIFTY LOST DAYS

BECAUSE of foundation troubles the contractor who was building Ten Pryor Street Building, Atlanta, Ga., was fifty days behind schedule. Winter construction with temperatures ranging from 20 to 60 degrees F. was necessary. "Incor" made it possible to remove forms in half the time required in summer, based on ordinary Portland cement performance. Using half the usual number of form-sets, rapid progress was made. Despite the fifty-day handicap the building was finished on time with an actual saving to the contractor.

brick and carpenter work follow closely after a floor is laid.

No Idle Workmen—No Delays

In the train of these economies, others follow. Less lumber and less labor are required because fewer forms are necessary with "Incor". The unit overhead cost is reduced because of the faster erection schedule. No follow-up workers are laid off; waiting for concrete is avoided. The total savings effected by "Incor" may be thus summarized: Curing costs reduced from 70 to 85 per cent; protection costs reduced from 60 to 80 per cent; forms removed the next day; overhead generally reduced; winter hazards minimized.

* * *

We have traveled far since Cheops built his great pyramid 4800 years ago and the Romans built their temples and aqueducts of concrete. First we saw concrete used because it could be made on the spot. That in itself marked a great advance over hauling blocks of stone by sheer animal or human power. But the ancients' concrete had its limitations. Not its inherent strength, but its mass and dead weight were important. Hence the thousands of tons poured to build a temple or a palace. There were few buildings as we now know them.

Portland Cement—A Great Advance

Then came Portland cement—twice as strong as blended cement. It could be used more freely in building self-supporting structures. When reinforced concrete construction was introduced about the middle of the 19th century Portland cement became the most flexible of building materials. It could be cast into slabs a few inches thick or into huge monoliths. With the development of modern machinery it becomes possible to place Portland cement in larger and larger masses. Mechanical mixing takes the place of muscles. Concrete is even prepared in factories and hauled to the building site. Conveyors and chutes are devised to transport a fluid mass which later congeals into stone. A few dozen men take the place of the hundreds required centuries ago.

More efficient methods of handling concrete by machines are not truly productive unless the cement itself keeps pace with them. If it takes weeks to cure concrete, the improvement in mixing and handling equipment is held in check. Research has been applied. Gradually the time required for curing Portland cement has been reduced from six or eight weeks to a month; then to three weeks, two weeks, one week. The whole technique of building roads, bridges, and other structures must be adapted to the hardening period. For centuries engineers have been hampered. Even a week is a serious economic and technical restriction. Given a new material, engineers will invariably devise a way of making the most of it.

"Incor"—A New Era in Cement

"Incor", a perfected high early strength cement, gives engineers a freer opportunity to realize economies. For the first time the detour problem presented by the building and repairing of highways for 27,000,000 vehicles is solved—and with a saving in money and time to the public and to business. A new technique of building concrete structures is at once introduced—a technique which makes the utmost use of high early and ultimate strengths, which eliminates much expensive form equipment and shortens the construction period. More than this, building throughout the entire year becomes an actuality. New profits are discovered in days which were once idle.

This is but the beginning. New and even more striking ways of capitalizing the twenty-four hour service strength of "Incor" will be discovered. Economies will also be realized by new bases for engineering designs. High early and high ultimate strengths will enable engineers to think more boldly. Lighter concrete structures are possible with "Incor", yet structures which are fully as strong as those now built. More hundreds of millions can thus be saved annually for the country as a whole. A new period in cement engineering opens.

Waldemar Kaempffert

GAINS 100 DAYS—SAVES $70,000

THE George Westinghouse Bridge carries the Lincoln Highway over Turtle Creek Valley, East Pittsburgh. The center span of 460 feet is the longest concrete arch in America. Faced with an overhead of $1,000 a day and freezing weather the contracting engineer used 24-hour "Incor" at the critical points. Three days after an arch rib was completed centers were transferred for re-use. One hundred days and $70,000 were thus saved by the contractor on the job.

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